

RESTRICTED CIRCULATION

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AGRICULTURAL MEMORANDUM NO. 590

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Bolting in Sugar Beet - Its Effect on the Seed Crop

1. Introduction

Sugar beet is wind pollinated, and it has long been recognised that plots for seed must be isolated from other flowering root crops, to reduce cross-pollination to a minimum. Chamberlain (1967) has given a very useful scheme of calculation for estimating the proportion of cross-pollination in a particular plot, known as the home plot. In that paper section 3 deals with pollination from the home plot, 4 and 5 with pollination from neighbouring plots, and 6 with pollination from distant sources. The emphasis is on the measures required to reduce the effect of a neighbouring plot to that of background from distant sources.

This note directs attention particularly to the effect of distant sources, and is based on sections 3 and 6 of Chamberlain's paper. In a dry summer such as 1973, root crops may produce up to 20% of flowering plants ("bolters"). The pollen from these can have an important effect on the purity of the seed crop.

2. Scheme of Calculation

Chamberlain's table 1 is reproduced in part below. The beet crop produces Q_0 pollens grains per m^2 per sec, of which P_H grains per m^2 per sec are deposited within the home plot.

Table 1 Proportion P_H/Q_0 of pollen produced in a square plot, which is deposited within the plot.

Area of plot (acres)	1.2	5	20	80
P_H/Q_0	0.11	0.19	0.28	0.36

P_H/Q_0 is nearly three times as large in a 20 acre plot as in a one acre plot. If self-pollination is wanted, it is clearly desirable to grow in large plots of one variety. It is unlikely that this simple result has yet made much impact on commercial practice.

Chamberlain's treatment of background pollen from the district generally, is to assume that for a large enough area the deposition P_B is equal to αQ_0 where Q_0 is (as before) the rate of production per unit area of crop, and α is the proportion of the district under sugar beet.

$$P_B = \alpha Q_0$$

$$\frac{P_B}{P_H} = \frac{\alpha Q_0}{P_H} \quad (\text{Chamberlain's eq 3}) \quad (1)$$

P_B/P_H is the ratio of background pollen to home pollen falling on the home plot. Values of P_H/Q_0 are drawn from table 1, and α must now be estimated.

3. Calculation of α , the proportion of a district covered by flowering beet

Let A be the area of a district
 a be the area under seed crop,
 assumed to flower 100%
 f be the fraction of the district under beet
 b be the proportion of bolters in the root crop

then

$$\alpha = \frac{\text{area under flowering beet}}{\text{total area}}$$

$$= \frac{Afb + a}{A}$$

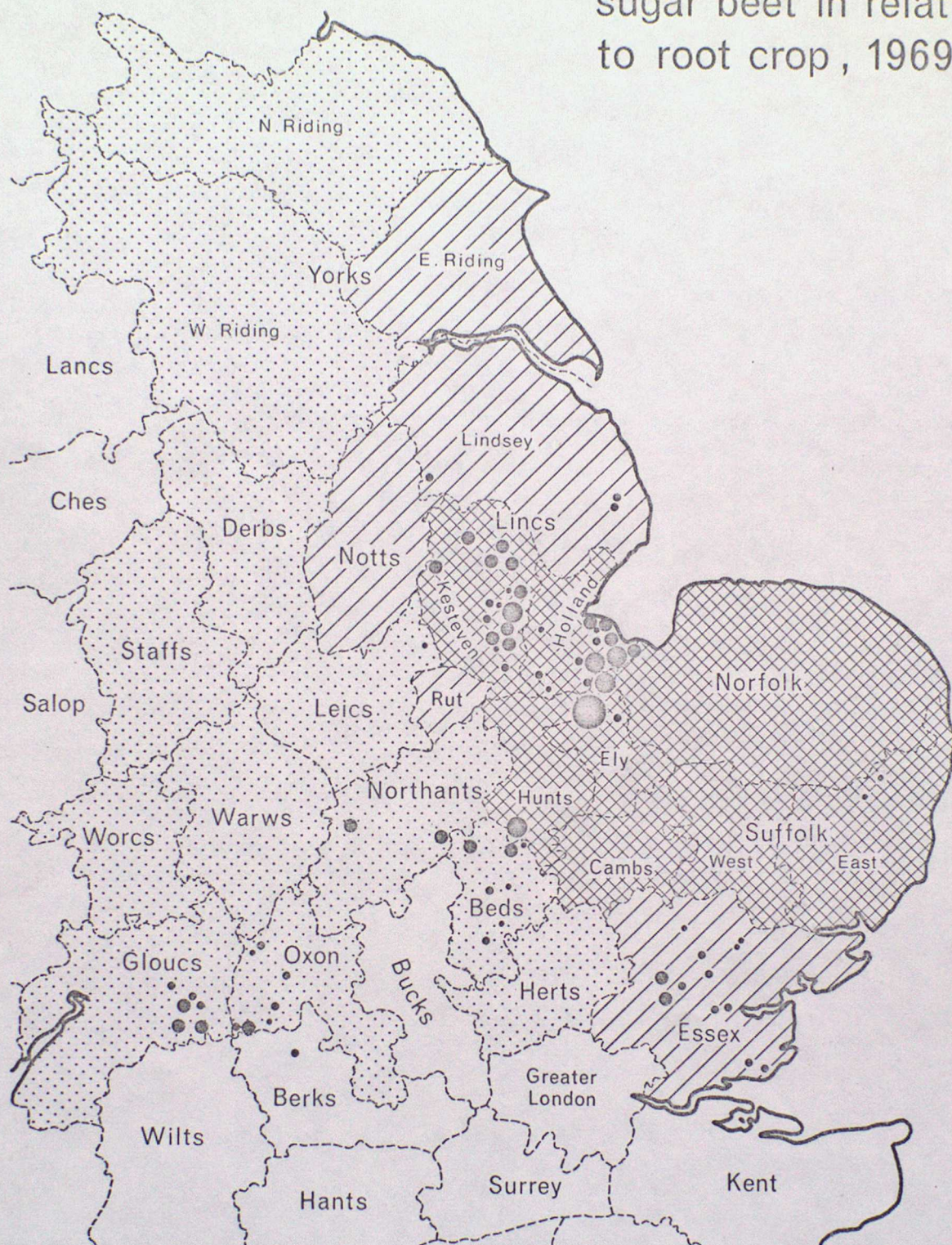
$$\alpha = fb + \frac{a}{A} \quad (2)$$

The annual Agricultural Statistics for 1971 (MAFF 1972) were used to estimate A and f by counties, the results being given in table 2.

Table 2		Area of ('000s of)	total	% area under
		sugar beet (acres)	area	sugar beet
Bedfordshire	*	2.3	304	0.8
Cambs & Ely	***	48	530	9.1
Derbyshire	*	0.6	634	0.1
Essex	**	22	904	2.4
Gloucestershire	*	0.8	803	0.1
Herefordshire	*	4.3	536	0.8
Hertfordshire	*	1.6	402	0.4
Hunts & Peterborough	***	20	310	6.4
Leicestershire	*	1.9	531	0.4
Lincs. Holland	***	24	267	9.0
Kesteven	***	27	460	5.9
Lindsey	**	39	973	4.0
Norfolk	***	112	1307	8.6
Northamptonshire	*	2.9	582	0.5
Nottinghamshire	**	20	536	3.7
Oxfordshire	*	0.4	476	0.1
Rutland	**	1.44	97	1.5
Shropshire	**	20	857	2.3
Staffordshire	*	5.3	733	0.7
Suffolk	***	58.5	945	6.2
Sussex, East	*	1.5	525	0.3
Warwickshire	*	1.3	619	0.2
Worcestershire	**	7.0	447	1.6
Yorks, E Riding	**	12.7	748	1.7
N Riding	*	10.8	1372	0.8
W Riding	*	12.2	1777	0.7
	*	0.1 to 1%)	% area under sugar beet	
	**	1 to 5%)		
	***	5 to 10%)		

In fig 1 this information is displayed in relation to the size and location of seed crops, taken from fig 2 of Longden and Scott (1973)

Fig 1 - Seed crop of
sugar beet in relation
to root crop, 1969



LOCATIONS AND SIZES OF
SUGAR BEET SEED CROPS

- Below 10 acres
- 11 - 25
- 26 - 50
- 51 - 100
- Over 100

% OF TOTAL COUNTY AREA
UNDER SUGAR BEET

-  0.1% - 1%
-  1% - 5%
-  Over 5% (max 9%)

NOT TO SCALE

Map drawn by M.B.C. Lands Arm, Leeds.
Feb 1974

Three areas of seed production then appear as being in areas of reasonably uniform root production. They are:

S Lincs/Ely	***
Essex	**
Gloucs/Oxon	*

Some assumptions will be made to estimate α in these three areas.

S Lincs/Ely. Total area that of Kesteven and Holland, 727,000 acres. Seed crop area $\frac{2}{3}$ of the national total, say 2500 acres. Say 8% of total area under beet.

Essex. Total area half that of Essex, say 450,000 acres. Seed crop area 10% of national total, say 375 acres. 1.4% of Essex is under beet.

Gloucs/Oxon. Total area that of Oxon, 476,000 acres. Seed crop area 10% of national total, say 375 acres. 0.1% of total area under beet.

Putting these guesses into eq 2 gives

$$\begin{aligned}\alpha &= (8b + 0.34) \times 10^{-2} && \text{S Lincs/Ely} \\ \alpha &= (2.4b + 0.083) \times 10^{-2} && \text{Essex} \\ \alpha &= (0.1b + 0.079) \times 10^{-2} && \text{Gloucs/Oxon}\end{aligned}$$

Table 3 shows α for proportions of bolters varying from 0.5% to 20%.

Table 3. Fraction of district area, α , covered by flowering beet, for different proportions of bolters in the root crop.

% bolters b	0.5 0.005	2 0.02	5 0.05	10 0.10	20 0.20
α { S Lincs & Ely	0.38	0.50	0.74	1.14	1.94
Essex	0.095	0.121	0.203	0.323	0.563
(%) { Gloucs/Oxon	0.079	0.081	0.084	0.089	0.099

4. Calculation of proportion of cross-pollination

The ratio of pollen fall from background to pollen fall from the home plot, is now calculated for plots of different sizes using eq 1 and tables 1 and 3, and the results are shown in table 4.

5. Conclusions

A number of crude assumptions are made in the course of the calculations, but the results will be right as to order of magnitude and show the correct trends with plot size, proportion of bolters etc.

Table 4 indicates that the cross-pollination ratio due to root crop background is always less than 1% in Gloucs/Oxon, and always more than 1% in S Lincs/Ely. In the latter area the cross-pollination is greater than 10% if the seed plot is less than 5 acres and there are 20% or more of bolters in the root crop, or if the seed plot is less than 1 acre and there are 10% or more of bolters in the root crop. The figures for Essex are intermediate between those of the other two areas considered.

Table 4. Ratio P_B/P_H (%) of pollen fall from background to pollen from home plot, for different sizes of plot and different proportions of bolters in the root crop.

Area of home plot (acres)	$\frac{P_H}{Q_0}$	S Lincs/Elly					Essex					Gloucs/Oxon					% bolters α (%)
		0.5	2	5	10	20	0.5	2	5	10	20	0.5	2	5	10	20	
		0.38	0.50	0.74	1.14	1.94	0.095	0.121	0.203	0.323	0.563	0.079	0.081	0.084	0.089	0.099	
1.2	0.11	3.5	4.5	6.7	10.4	17.6	0.9	1.1	1.9	2.9	5.1	0.7	0.7	0.8	0.8	0.9	
5	0.19	2.0	2.6	3.9	6.0	10.2	0.5	0.6	1.1	1.7	3.3	0.4	0.4	0.4	0.5	0.5	
20	0.28	1.4	1.8	2.6	4.1	6.9	0.3	0.4	0.7	1.1	2.0	0.3	0.3	0.3	0.3	0.4	
80	0.36	1.1	1.4	2.1	3.2	5.4	0.2	0.3	0.6	0.9	1.6	0.2	0.2	0.2	0.3	0.3	

6. Acknowledgements

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7. References

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